Corey Jonathan Cochrane – Scientist / Technologist - Planetary Interiors and Geophysics

Currently working at NASA's Jet Propulsion Laboratory, California Institute of Technology, with primary research interests in the study of planetary magnetic fields and plasmas, through the development of next-generation quantum-based magnetometers, novel signal processing methodologies, and strategic design and formulation of future planetary mission concepts.

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RESEARCH INTERESTS

Science Planetary Magnetic Field Modeling ▪ Planetary Interior Induction Modeling ▪ Magnetosphere-Moon Interactions ▪ Plasma and Magnetospheric Physics ▪ Magnetic Resonance Spectroscopy (EPR / NMR / EDMR / ODMR) ▪ Raman Spectroscopy

Signal Processing Forward/Inverse Mathematical Modeling ▪ Digital Signal Processing ▪ Adaptive Filtering ▪ Image Processing ▪ Fourier Analysis ▪ Artificial Neural Networks ▪ Wavelets ▪ Spherical Harmonics ▪ Radar Signal Processing ▪ Communication Signal Processing

Instrument Development Magnetometers (quantum solid-state, optically pumped alkali vapor, fluxgate) ▪ Magnetic Resonance Spectrometers (EPR / NMR / EDMR / ODMR) ▪ FMCW Doppler Radar ▪ Raman Spectrometer

EDUCATION

May 2013 **Ph.D.** - Engineering Science and Mechanics, *Penn State University, University Park, PA*

Dec 2007 **M.S.** - Electrical Engineering, *Penn State University, University Park, PA*

Dec 2004 **B.S.** - Electrical Engineering, *Penn State University, University Park, PA*

WORK HISTORY

2022 – 2023 **Jet Propulsion Laboratory, California Institute of Technology,** *Pasadena, CA*
Scientist - Planetary Interiors and Geophysics

2015 – 2022 **Jet Propulsion Laboratory, California Institute of Technology,** *Pasadena, CA*
Technologist - Optical and Electro-Mechanical Microsystems Group

2013 – 2015 **Jet Propulsion Laboratory, California Institute of Technology,** *Pasadena, CA*
NASA Postdoctoral Program (NPP) Fellowship – emphases in magnetometry and Raman spectroscopy

2013 – 2023 **Blue Spin LLC,** *University Park, PA*
Co-owner, Co-founder of startup company developing low-field continuous wave EDMR spectrometers

2010 – 2013 **Penn State Semiconductor Spectroscopy Lab,** *University Park, PA*
Graduate Research Assistant – emphasis in magnetic resonance spectroscopy and signal processing

2008 – 2010 **Boeing Space & Intelligent Systems,** *El Segundo, CA*
Satellite Communication Systems Engineer – DSP Algorithms Groups

2004 – 2008 **Penn State Semiconductor Spectroscopy Lab,** *University Park, PA*
Graduate Research Assistant – emphasis in magnetic resonance spectroscopy and signal processing

2003 – 2004 **NASA Ames Research Center,** *Mountain View, CA*
Undergraduate Student Research Program (USRP) Intern - Bio-Visualization Group

MISSION EXPERIENCE

2016 – 2023 **Europa Clipper Mission**
- Co-Investigator and Investigation Scientist for Plasma Instrument for Magnetic Sounding (PIMS)
- Calibration Lead (ground and in-flight) and Investigation Scientist for the Europa Clipper Magnetometer (ECM)
- Interior Working Group and Radiation Focus Group Facilitator
- Europa magnetic induction modeling, spacecraft magnetic field modeling and field removal, magnetometer and plasma science requirements definition, Clipper/JUICE joint science investigation

2022 – 2023 **Psyche Mission,** science team collaborator
- Magnetic field modeling of the Psyche spacecraft

2021 – 2022 **Uranus Moon Discovery Mission Concept (Urania):** Co-Investigator
- Moon magnetic induction modeling, subsurface ocean detection algorithms, trajectory assessment, STM development

2019 – 2021 **Trident Discovery Mission Concept:** Science affiliate, Ocean Detection Lead
- Triton magnetic induction modeling, subsurface ocean detection algorithms, magnetometer requirement, STM development

INSTRUMENT DEVELOMENT EXPERIENCE

2016 - 2023 **Silicon Carbide Magnetometer (SiCMag) – PI** *patented*
- Electrically detected quantum centers in SiC. Absolute scalar and vector modes

2021 - 2023 **Optically Pumped Solid-State Quantum Magnetometer (OPuS-MAGNM) – Co-I**
- Electrically detected quantum centers in SiC. Absolute scalar and vector modes

2019 - 2023 **Scalar Vector Helium (SVH) – Co-I**
- Optically pumped ^{4}He vapor magnetometer. Absolute scalar and vector modes.

2016 - 2019 **Gas and Ice Spectrometer Radar (GAISR) – Co-I**
- FPGA algorithm development lead for frequency modulated continuous wave (FMCW) architecture

2013 - 2017 **Time Resolved Raman Spectrometer (TRRS) – Co-I**
- FPGA algorithm development lead
- Developed classification algorithms for identifying components in mineral mixtures
- Developed focus stacking algorithms / unsupervised image segmentation for TRRS imaging systems

2010 - 2015 **Low-Field Electrically Detected Magnetic Resonance Spectrometer (LF-EDMR) - PI** ***patented***
- Field swept architecture (± 300 G), variable frequency RF, magnetic field modulation, multi-band virtual lock-in
- Developed an adaptive signal averaging algorithm to expedite acquisition time ***patented***
- Developed an adaptive noise canceller in an FPGA to reduce noise in EDMR spectrometers

RELEVENT EXPERIENCE

2008 - 2010 **Wideband Global Satellite (WGS) Block IIA and Evolution,** Boeing Space & Intelligence Systems**,** *El Segundo, CA*
- Wideband channelizer ASIC: FFT implementation/switching, time/frequency permutation, scrambling algorithms, waveform disguise, and satellite/ground synchronization.
- Transformational Communication Satellite (TSAT)**:** Design/verification of ASIC packet/circuit switching, CRC algorithms

2004 - 2005 **Digital Sun Sensor for Spirit III Rocket Program (ESPRIT),** *Penn State University, University Park, PA*
- Designed and built PIC-microcontroller based digital sun sensor for estimating the sun angle
- Successful data acquisition after launch in Andøya Rocket Range Norway, July 2006

2003 - 2004 **Earbot Scorpion Robot,** *NASA Ames Research Center, Mountain View, CA*
- Developed artificial neural network (ANN) and built inertial measurement unit (IMU) to mimic the human vestibular system to stabilize imaging systems for use on an eight-legged Scorpion robot.

AWARDS AND RELEVANT INFORMATION

Mar 2024 **JPL Leadership Mentoring Program** – demonstrating technical leadership on a flight project and science/technology program
Sept 2023 **JPL Team Award** – for ECM calibration team performing a successful calibration of Europa Clipper Magnetometer (ECM)
Sept 2023 **JPL Team Award** – for ECM electronics teams for resolution of the op-amp noise anomaly associated with ECM electronics
Jun 2023 **JPL Team Award** – for Europa Clipper Investigation Scientists for development of the Science Strategic Planning Guide
Sep 2022 **JPL Voyager Award** – for Europa Clipper spacecraft magnetic field modeling to ensure success of ECM
Mar 2022 **NASA Group Achievement Award** to the Europa Clipper Magnetometer Team
Sep 2021 **JPL Charles Elachi Award** - outstanding work on ocean detection algorithms to enable future ocean world mission
Sep 2021 **JPL Team Award** – For Europa Clipper Magnetometer team executing a successful Instrument CDR
Jun 2019 **JPL Voyager Award** – work performed for Europa Clipper Magnetometer (ECM) investigation
May 2019 **Penn State Early Career Recognition Award** in Engineering Science and Mechanics
Jul 2018 **JPL Team Award** - work performed for Europa Clipper ICEMAG investigation
May 2017 **JPL Ed Stone Award** - outstanding publication and prototype of a next-generation solid-state magnetometer
Apr 2017 **JPL Team Award** - for Europa Clipper Investigative Scientist Team
Apr 2016 **JPL Voyager Award -** for NASA selection of PICASSO proposal on next-generation solid-state magnetometer
Apr 2015 **Penn State Early Career Recognition Alumni Award** in Electrical Engineering
May 2013 **NASA Postdoctoral Program (NPP) Fellowship** recipient
May 2013 **Dr. Paul A. Lester Memorial Award** outstanding research by a Penn State Engineering Science graduate student
Jan 2007 **Young Scientist Award** at the Physics and Chemistry of Semiconductor Interfaces Conference.
Mar 2007 **Best Poster** at the Nano and Giga Challenges Conference
Apr 2005 Passed the Fundamentals of Engineering (FE/EIT) Exam

NASA Awarded Research Grants

- **NASA Preparatory Science Investigations for Europa (2024-2026), Co-I:** Joint Inversion of Magnetic Induction and Gravity Science Measurements Using New Laboratory Data for Europa Analog Solutions
- **NASA Planetary Instruments for the Advancements of Solar System Observations (2021-2024), Co-I:** Optical SiC Quantum Magnetometer
- **NASA Planetary Mission Concept Study (2020), Co-I**: Neptune Odyssey: A Large Class Mission Study for the Exploration of the Neptune-Triton System.
- **NASA Innovative Advanced Concepts (NIAC) Phase I (2019), Co-I**: Low-Cost SmallSats to Explore to Our Solar System's Boundaries.
- **NASA Maturation of Instruments for Solar System Exploration (2019-2021), Co-I**, WAter-vapor Sounding Short-range Radar for Martian Surface
- **NASA Planetary Instruments for the Advancements of Solar System Observations (2016-2020), PI:** Solid State Quantum Magnetometer.

JPL Awarded Research Grants

- **JPL Spontaneous R&TD (2023), PI**: Characterization of JFET magnetic field sensor for use with SiC Magnetometer
- **JPL Spontaneous R&TD (2023), Co-I**: 3D immersive visualization of spacecraft (Clipper/Psyche) magnetic fields
- **JPL Strategic R&TD (2020-2023.), Co-I:** Ice Giant Science Leadership
- **JPL Strategic R&TD (2020-2023), PI**: Magnetometer Technology Development for the ARTEMIS Initiative
- **JPL Center for Academic Partnerships (2021), PI**: US Naval Academy Quantum Spin Creation and Characterization Collaboration
- **JPL Spontaneous R&TD (2020), Co-I**: 3D Printing Ceramics for Magnetometer Structures

- **JPL Strategic University Research Partnership (2020), Co-I**: Characterization of Thermostatic Magnetic Interference to Magnetometers
- **JPL Strategic University Research Partnership (2019), Co-I**: Monte Carlo approach to retrieve Europa's Ocean Parameters
- **JPL Strategic R&TD (2018-2020), Co-I:** Responsive Onboard Science for the Europa Clipper Mission
- **JPL Center for Academic Partnerships (2017), PI**: Electrically Detected Magnetic Resonance (EDMR) Spectroscopy Collaboration with Penn State
- **JPL Center Innovation Fund (2015), PI:** Solid-state quantum magnetometer for vectorized field sensing in harsh planetary environments.

Patents

1. Corey Cochrane, "Self-calibrating solid-state based magnetometer for vectorized field sensing via zero-field spin dependent recombination in silicon carbide Microelectronics", Patent Issued November 2020 (CIT 7171-P), U.S. Patent No. US 10,838024 B2, Patent Application No. 15/969,466
2. Corey Cochrane, Patrick Lenahan, "Zero- & Low-Field Transport Detection System", provisional patent submitted October 2012 through Penn State University, accepted on November 7, 2017. U.S. Patent No. 9,810,756, U.S. Patent Application No. 14/050,615
3. Corey Cochrane, Patrick Lenahan, "Adaptive Signal Averaging Method which Enhances the Sensitivity of Continuous Wave Magnetic Resonance and Other Analytical Measurements", Filled Sept 10, 2009. Patent Issued Oct. 2012. U.S. Patent No. US 2010/0066366 A1, 9,810,756, Patent Application No. 12/557,123

Professional Memberships

1. American Geophysical Union (AGU)
2. Institute of Electrical and Electronics Engineers (IEEE)

Computer Background

Programming: NIAF SPICE toolkit, MATLAB, Labview, C, C++, C#, Verilog, System Verilog, PIC, dsPIC, JavaScript, HTML
Software: STK, Xilinx Vivado/ISE, Mentor Graphics QuestaSim ModelSim, Altium PCB
Operating Systems: Windows, UNIX, Linux

Professional Service

1. Program committee of the International Conference on Silicon Carbide and Related Materials 2024, Quantum Sensing Special Session 2024.
2. NASA Science and Technology Partnership Quantum Sensing Study - Magnetometry Working Group (2023)
3. Peer reviewer for NASA's Heliophysics Future Investigators in NASA Earth and Space Science and Technology (FINESST)
4. Associate Editor of Quantum Sensing and Metrology - a journal within Frontiers in Quantum Science and Technology (2022 – 2023)
5. Served on the MagQuest Judging Panel - National Geospatial-Intelligence Agency competition for novel approaches to geomagnetic data collection for the World Magnetic Model (2019)
6. Reviewer for many SBIR proposals and various journals including Applied Physics Letters (APL), Journal of Applied Physics (JAP), Review of Scientific Instruments (RSI), Journal of Magnetic Resonance (JMR), Journal of Geophysical Research (JGR), Geophysical Research Letters (GRL), IEEE Transactions on Geoscience and Remote Sensing.
7. Mentor for dozens of students under JPL, Europa Clipper, Europa Clipper H2O program, Center for Academic Partnerships (CAP), NPP postdoc advisor and co-advisor, JPL postdoc advisor, intern advisor, graduate student lab advisor.

Peer-Reviewed Publications

1. C. B. Phillips, J. E. C. Scully, M. E. Cameron, et al., "A Reconnaissance Strategy for Landing on Europa, based on Europa Clipper Data, submitted to Space Science Reviews", 2024.
2. R. T. Pappalardo, B. J. Buratti, H. Korth, et al., "Science Overview of the Europa Clipper Mission", submitted to Space Science Reviews, 2024.
3. I. J. Daubar, A. G. Hayes, G. C. Collins, K. L. Craft, et al., "Planned Geological Investigations of the Europa Clipper Mission", accepted in Space Science Reviews, 2023.
4. Westlake, J.H., McNutt, R.L., Grey, M, Coren, D., Rymer, A. M., Cochrane, C. J. et al., "The Plasma Instrument for Magnetic Sounding (PIMS) on the Europa Clipper Mission", Space Sci Rev 219, 62 (2023). https://doi.org/10.1007/s11214-023-01002-9
5. Meitzler, R., Jun, I., Blase, R., Cassidy, T., Clark, R., Cochrane, C. J. et al. Investigating Europa's Radiation Environment with the Europa Clipper Radiation Monitor. Space Sci Rev 219, 61 (2023). https://doi.org/10.1007/s11214-023-01003-8
6. A. Romero-Wolf, G. Steinbruegge, J. Castillo-Rogez, C.J. Cochrane, et al., "Feasibility of Passive Sounding of Uranian Moons using Uranian Kilometric Radiation", arXiv preprint arXiv:2305.05382, 2023.
7. M.G. Kivelson, X. Jia, K.A. Lee, C.A. Raymond, K.K. Khurana, M.O. Perley, J.B. Biersteker, J. Blacksberg, R. Caron, C.J. Cochrane, et al., "The Europa Clipper Magnetometer", *Space Science Reviews*, 219, Article number: 48 (2023)
8. F. Petricca, A. Genova, J.C. Castillo-Rogez, M.J. Styczinski, C.J. Cochrane, S.D. Vance, "Characterization of Icy Moon Hydrospheres Through Joint Inversion of Gravity and Magnetic Field Measurements", *Geophysical Research Letters*, Vol. 50, Issue 7, 2023.
9. JH Roberts et al., "Exploring the Interior of Europa with the Europa Clipper", *Space Science Reviews*, 219, Article number: 46 2023.
10. C.J. Cochrane, et al., Magnetic Field Modeling and Visualization of the Europa Clipper Spacecraft, *accepted for publication in Space Science Reviews*, 2023.
11. Biersteker, J. B., Weiss, B. P., Cochrane, C. J., et. al., "Revealing the interior structure of icy moons with a Bayesian approach to magnetic induction measurements", *accepted for publication in Planetary Science Journal*, 2023.
12. B.W. Weiss, J.M.G. Merayo, J. Ream, R. Oran, P. Brauer, C. J. Cochrane, et. al, "The Psyche Magnetometry Investigation", *Space Science Reviews*, 219 (3), 22, 2023.
13. J. C. Castillo-Rogez, M. M. Daswani, C. R. Glein, S. D. Vance, C. J. Cochrane, "Contribution of Non-Water Ices to Salinity and Electrical Conductivity in Ocean Worlds", Geophysical Research Letters, vol. 49, issue 16, 2022.
14. C. J. Cochrane, et al., Single- and Multi-Pass Magnetometric Subsurface Ocean Detection and Characterization in Icy Worlds Using Principal Component Analysis: Application to Triton, *Earth and Space Physics*, 2022.
15. A.S Daigavane, K.L. Wagstaff, G. Doran, C. J. Cochrane, et al., "Unsupervised detection of Saturn magnetic field boundary crossings from plasma spectrometer data", *Computers and Geoscience*, 2022.

16. M. Styczinski, S. D. Vance, E. M. Harnett, and C. J. Cochrane, "An analytic solution for evaluating the magnetic field induced from an arbitrary, asymmetric ocean world", *Icarus*, Volume 376, April 2022, 114840.
17. C.J. Cochrane, S. Vance, T. Nordheim, et al., "In Search of Subsurface Oceans within the Uranian Moons", *JGR Planets*, 2021.
18. L. Liuzzo, C. Paty, C. J. Cochrane, et al., Triton's Interaction with Neptune's Magnetospheric Plasma, *JGR: Space Physics*, Volume126, Issue11, 2021.
19. R. J. Cartwright, et al., "A CO2 ice cycle on Ariel? Radiolytic production and migration to low latitude cold traps", *accepted for publication in Planetary Science Journal*, 2021.
20. E. J. Leonard, C. Elder, T. A. Nordheim, R. Cartwright, D.A. Patthoff, C. Beddingfield, C.J. Cochrane, et al. "UMaMI: A New Frontiers-style Mission Concept to Explore the Uranian System", Planet. Sci. J. 2 174, 2021.
21. A. M. Rymer, et al., "Neptune-Odyssey: A Flagship Concept for the Exploration of the Neptune-Triton System", Planet. Sci. J., 2:184 (15pp), 2021 October.
22. S. D. Vance, M. J. Styczinski, B. G. Bills, C. J. Cochrane, et al, "Magnetic induction responses of Jupiter's ocean moons including effects from adiabatic convection", *JGR Planets*, 126,2, 2021.
23. B. R. Manning, C. J. Cochrane, P. M. Lenahan, "An improved adaptive signal averaging technique for noise reduction and tracking enhancements in continuous wave magnetic resonance", Review of Scientific Instruments 91 (3), 033106, 2020.
24. C.J. Cochrane, et. al., "An FPGA-based signal processor for FMCW Doppler radar and spectroscopy", *IEEE Transactions on Geoscience and Remote Sensing*, Volume: 58, Issue: 8, 2020.
25. K. B. Cooper, R. R. Monje, R. J. Dengler, C. J. Cochrane, et al, "A Compact, Low Power Consumption, and Highly Sensitive 95 GHz Doppler Radar", *IEEE Sensors Journal* 20 (11), 5865-5875, 2020.
26. J. Blacksberg, E. Alerstam, C. J. Cochrane, et. al., "A miniature high-speed, low-pulse energy picosecond Raman spectrometer for identification of minerals and organics in planetary science", OSA Applied Optics, 59 (2), 433-444, 2020.
27. K. Cooper, S. Durden, C.J. Cochrane, et al, "Using FMCW Doppler Radar to Detect Targets up to the Max. Unambiguous Range", *IEEE TRGS*, **99**, 1-5 *2017.*
28. C.J. Cochrane, et. al, "Vectorized magnetometer for space applications using electrical readout of atomic scale defects in silicon carbide", *Nature Scientific Reports*, 37077, doi:10.1038/srep37077, 2016.
29. J. Blacksberg, E. Alesrstam, Y. Maruyama, C.J. Cochrane, G. Rossman, "A Miniaturized Time-Resolved Raman Spectrometer for Planetary Science Based on a Fast Single Photon Avalanche Diode (SPAD) Detector Array", *Applied Optics*, **55** (4), pp: 739-748, 2016.
30. M.J. Mutch, T. Pomorski, B.C. Bittel, C.J. Cochrane, "Band diagram for low-k/Cu interconnects: The starting point for understanding back-end-of-line (BEOL) electrical reliability", *Microelectronics Reliability*, **63**, pp: 201-213, (2016).
31. C.J. Cochrane, J. Blacksberg., "A fast classification scheme in Raman spectroscopy for the identification of mineral mixtures using a large database with correlated predictors", *IEEE TRGS*, **53**, 8, pp: 4259-4274, (2015).
32. M.A. Anders, P.M. Lenahan, C.J. Cochrane, et al., "Relationship between the 4H SiC/SiO_2 interface structure and electronic properties explored by electrically detected magnetic resonance", **62**, 2, pp: 301-308, (2015). **(Invited)**
33. C.J. Cochrane, et al., "Spin counting in electrically detected magnetic resonance via low-field defect state mixing", *Applied Physics Letters,* **104**, 9 (2014).
34. C.J. Cochrane, P.M. Lenahan, "Detection of interfacial Pb centers in Si/SiO2 metal-oxide-semiconducting field-effect transistors via zero-field spin dependent recombination with observation of precursor pair spin-spin interactions", *Applied Physics Letters, 103, 5,* (2013).
35. C.J. Cochrane, P.M. Lenahan, A.J. Lelis, "The effect of nitric oxide anneals on silicon vacancies at and very near the interface of 4H SiC metal oxide semiconducting field effect transistors using electrically detected magnetic resonance", *Applied Physics Letters*, **102**, 193507, (2013).
36. T.A. Pomorski, B.C. Bittel, C.J. Cochrane, et al., "Defects and electronic transport in hydrogenated amorphous SiC films of interest for low dielectric constant back end of the line dielectric systems", *Journal of Applied Physics*, **114**, 7, 074501, (2013).
37. C.J. Cochrane, P.M. Lenahan, "Zero-field detection of spin dependent recombination with direct observation of electron nuclear hyperfine interactions in the absence of an oscillating electromagnetic field", *Journal of Applied Physics,* **112**, 12, *(2012).*
38. C.J. Cochrane, P.M. Lenahan, "On the Performance of Adaptive Signal Averaging", *Review of Scientific Instruments*., **83,** 105108, (2012).
39. C.J. Cochrane, P.M. Lenahan, A.J. Lelis, "Identification of a Silicon Vacancy as an Important Defect in 4H SiC MOSFETs" *Applied Physics letters*, vol. **100**, issue 2, 023509, (2012).
40. C.J. Cochrane, P.M. Lenahan, A.J. Lelis, "An Electrically Detected Magnetic Resonance Study of Performance Limiting Defects in SiC MOSFETs", *Journal of Applied Physics*, Vol. 109, Issue 1, No. 014506, Jan 1 (2011).
41. C.J. Cochrane, P.M. Lenahan, A.J. Lelis, "Direct Observation of Lifetime Killing Defects in 4H SiC Epitaxial Layers through Spin Dependent Recombination in Bipolar Junction Transistors", *Journal of Applied Physics*, Vol. 105, Issue 6, No. 064502, March 15 (2009).
42. C.J. Cochrane, P.M. Lenahan, "Real Time Exponentially Weighted Recursive Least Squares Adaptive Signal Averager for Enhancing the Sensitivity of Electrically Detected Magnetic Resonance", *Journal of Magnetic Resonance* Vol. 195, Issue 1, pp. 17-22 (2008).
43. C.J. Cochrane, P.M. Lenahan, G. Bersuker, A. Neugroschel, "Observations of Negative Bias Stressing Interface Trapping Centers in Metal Gate HfO_2 Field Effect Transistors Using Spin Dependent Recombination", *Applied Physics Letters*, Vol. 90, Issue12, No. 123502, (2007).
44. C.J. Cochrane, P.M. Lenahan, A.J. Lelis, "Deep Level Defects Which Limit Current Gain in 4H SiC Bipolar Junction Transistors", *Applied Physics Letters,* Vol. 90, Issue 12, No. 123501, (2007).
45. J.P. Campbell, P.M. Lenahan, C.J. Cochrane, A.T. Krishnan, S. Krishnan, "Atomic-Scale Defects Involved in the Negative-Bias Temperature Instability", *IEEE Transactions on Device and Materials Reliability,* Vol. 7, Issue 4, pp. 540 - 557, Dec. 2007.

Conference Proceeding Publications

1. A. Daigavane, K. L. Wagstaff, G. Doran, C. J. Cochrane, "Detection of Environment Transitions in Time Series Data for Responsive Science", MileTS '20, August 24th, 2020, San Diego, California, USA.
2. O Pradhan, K Cooper, et al., "Submillimeter Wave Differential Absorption Radar for Water Vapor Sounding in the Martial Atmosphere", *IGARSS 2020-2020 IEEE International Geoscience and Remote Sensing Symposium*
3. C.J. Cochrane, H. Kraus, et al., "Magnetic Field Sensing with 4H SiC Diodes: N vs P Implantation", *Mat. Sci. For 924, pp: 988-992, (2018).*
4. A. Rymer, et al., "Solar System Ice Giants: Exoplanets in our Backyard", Exoplanet Science Strategy White Paper, submitted to the National Academies of Sciences, Space Studies Board, 9 March 2018.
5. K. Cooper, et al., "A W-band Comet-Jet Doppler Radar Prototype", IEEE Radar Conference, pp. 202-205, (2018)
6. C.J. Cochrane, J. Blacksberg, et al., "Magnetic field sensing with atomic scale defects in SiC devices", *Mat. Sci. For., 858, pp: 265-268, 2016.*
7. C.J. Cochrane, et al., "Qualitative EDMR for device reliability studies", *IEEE International Integrated Reliability Workshop Final Report"*, 6-9, 2014.

8. P.M. Lenahan, C.J. Cochrane, et al., "High, low, and zero-field SDR in 4H SiC MOSFETS and BJTs", *Electrochem. Soc.*, **64**, 7, pp: 111-122, (2014).
9. C.J. Cochrane, P.M. Lenahan, "Zero/low field SDR and SDT used for atomic scale probes of NBTI and TDDB", *IEEE International Integrated Reliability Workshop Final Report"*, pp. 88-89, Oct. 2013.
10. C.J. Cochrane, P.M. Lenahan, "A Means to Study Reliability Based Defects in Fully Processed Devices Utilizing Zero-Field Spin Dependent Transport", *Proceedings of the IEEE International Integrated Reliability Workshop"*, pp. 45-47, Oct. 2012.
11. C.J. Cochrane, P.M. Lenahan, A.J. Lelis, "Definitive Identification of an Important 4H SiC MOSFET Interface/Near Interface Trap", *Materials Science Forum*, Vols. 717-720, pp. 433-436, (2012).
12. P.M. Lenahan, C.J. Cochrane, J.P. Campbell, J.T. Ryan, "Electrically Detected Magnetic in Dielectric Semiconductor Systems of Current Interest", *Silicon Nitride, Silicon Dioxide, and Emerging Dielectrics*, 35, 4, pp. 605-627, (2011).
13. C.J. Cochrane, B.C. Bittel, P.M. Lenahan, "EDMR and EPR Studies of 4H SiC MOSFETs and Capacitors", *Mat. Sci. For.*, Vol 645-648, pp. 527-530 (2010).
14. C.J. Cochrane, P.M. Lenahan, A.J. Lelis, "Electrically Detected Magnetic Resonance Studies on Variously Processed 4H SiC Metal Oxide Semiconductor Field Effect Transistors", *Materials Science Forum Vols. 600-603*, pp.719-722 (2009).
15. C.J. Cochrane, P.M. Lenahan, A.J. Lelis, "Direct Observation of Lifetime Killing Defects in 4H SiC Epitaxial Layers via Spin Dependent Recombination in Transistors", *Materials Science Forum*, Vols. 615-617, pp.299-302 (2009).
16. C.J. Cochrane, P.M. Lenahan, A.J. Lelis, "Interface Traps in SiC MOSFETs", *IEEE IIRW Workshop Final Report*, pp. 68-71 (2008).
17. C.J. Cochrane, P.M. Lenahan, A.J. Lelis, "Electrically Detected Magnetic Resonance Studies of Processing Variations 4H SiC Based MOSFETs", *International Semiconductor Device Research* Symposium, Vol. 1-2, pp.497-498 (2007).
18. G. Reichard and C.J. Cochrane, "ESPRIT Sun Sensor: Results and Future Use", *Proceedings of the European Space Agency Conference*, (2007).
19. C.J. Cochrane, P.M. Lenahan, G. Bersuker, A. Neugroschel, "Negative Bias Temperature Stress Interface Trapping Centers in Metal Gate HfO_2 Field Effect Transistors Using Spin Dependent Recombination", *IEEE International Integrated Reliability Workshop*, pp. 11-15 (2006).
20. A. Neugroschel, G. Bersuker, R. Choi, C.J. Cochrane, P. Lenahan, D. Heh, C. Young, C.Y. Kang, B.H. Lee, and R. Jammy, "An Accurate Lifetime Analysis Governing NBTI Mechanisms in High-K/SiO_2 Gate Stacks", *IEEE International Electron Devices Meeting Manuscript*, Dec. 11-13, pp. 53-56(2006).

Magazine Publications

1. C.J. Cochrane "Magnetometer for Vectorized Field Sensing via Zero-Field Spin-Dependent Recombination in SiC Microelectronics", *NASA Tech Briefs*, NPO-49854 May 1, 2016.
2. C.J. Cochrane "Fast Classification Method for Multivariate Mixtures of Spectroscopic Responses", *NASA Tech Briefs,* NPO-49590, pp: 50-51, **39**, 1, Jan. 2015.
3. C.J. Cochrane, P.M. Lenahan, "Adaptive Signal Averaging Technique that Reduces the Acquisition Time of Continuous Wave Magnetic Resonance Experiments", *EPR Newsletter,* Vol. 19, No. 4, pp.13-14, (2010). **(Invited)**

First Author Conference Oral Presentations

1. International Conference on Silicon Carbide and Related Materials (ICSCRM), 2022 (Davos, Switzerland) **(Invited)**
2. Magnetospheres of the Outer Planets (MOP), 2022 (Liège, Belgium) **(Invited)**
3. American Geophysical Union (AGU) Fall Meeting, 2021 (New Orleans, LA) **(Invited)**
4. Quantum Innovation Workshop (The Inter. Sym. On Quantum Science, Technology, and Innovation, 2021 (Tokyo, Japan) **(Invited)**
5. Lunar and Planetary Science Conference (LPSC), 2021 (Virtual)
6. Asia Oceania Geosciences Society (AOGS), 2020 (Hongcheon, South Korea)
7. Workshop on Quantum Sensing and Magnetometry, 2019 (Ban Honnef, Germany) **(Invited)**
8. 15th Annual Congress of the Society for Brain Mapping & Therapeutics (SMBT), 2018 (Los Angeles, CA) **(Invited)**
9. International Conference on Silicon Carbide and Related Materials (ICSCRM), 2017 (Washington, DC)
10. Instruments for Planetary Missions (IPM), 2016 (Pasadena, CA)
11. Rocky Mountain Conference on Magnetic Resonance, 2016 (Breckenridge, Colorado)
12. Silicon Happy Valley, 2016 (University Park, PA) **(Invited)**
13. International Conference on Silicon Carbide and Related Materials (ICSCRM), 2015 (Giardini Naxos, Italy)
14. IEEE International Integrated Reliability Workshop (IIRW), 2014 (Lake Tahoe, CA)
15. International Conference on Defects in Semiconductors (ICDS), 2013, (Bologna, Italy)
16. International Conference on Silicon Carbide and Related Materials (ICSCRM), 2013 (Miyazaki, Japan)
17. IEEE International Integrated Reliability Workshop (IIRW), 2013 (Lake Tahoe, CA)
18. IEEE Conf. on Reliability Science for Advanced Materials and Devices (RSAMD), 2013 (Golden, CO) **(Invited)**
19. IEEE International Integrated Reliability Workshop (IIRW), 2012 (Lake Tahoe, CA)
20. Electronic Materials Conference (EMC), 2012 (University Park, PA)
21. Materials Research Society (MRS) 2012 (San Francisco, CA)
22. International Semiconductor Device Research Symposium (ISDRS) 2011, (College Park, MD)
23. SiC MOS Workshop at the Army Research Laboratory, 2011 (Adelphi, Maryland)
24. International Conference on Defects in Semiconductors (ICDS), 2011 (Nelson, New Zealand)
25. Electronic Materials Conference (EMC), 2011 (Santa Barbara, CA)
26. Physics and Chemistry of Semiconductor Interfaces (PCSI), 2008 (Santa Fe, New Mexico)
27. Silicon Carbide MOS Workshop at the Army Research Laboratory, 2007 (Adelphi, Maryland)
28. Ultra Large Scale Integrated Circuits vs. Thin Film Transistor Conference (ULSI vs. TFT), 2007 (Barga, Italy)
29. Rocky Mountain Conference on Analytical Chemistry (RMC), 2007 (Breckenridge, Colorado)
30. Electronic Materials Conference (EMC), 2007 (South Bend (Notre Dame), Indiana)
31. Electronic Materials Conference (EMC), 2006 (State College (Penn State University), Pennsylvania)
32. Workshop on Dielectrics in Microelectronics (WoDiM), 2006 (Catania, Italy)
33. Materials Research Society (MRS), 2006 (San Francisco, California)

First Author Conference Poster Presentations

1. American Geophysical Union (AGU) Fall Meeting, 2023 (San Francisco, CA)
2. International Conference on Silicon Carbide and Related Materials (ICSCRM), 2023 (Sorrento, Italy)
3. Magnetospheres of the Outer Planets (MOP), 2019 (Sendai Japan)
4. European Conference on Silicon Carbide and Related Materials (ECSCRM), 2018 (Birmingham, UK)
5. European Conference on Silicon Carbide and Related Materials (ECSCRM), 2016 (Halkidiki, Greece)
6. JPL Postdoc Research Day 2015, (Pasadena, CA)
7. Lunar and Planetary Science Conference (LPSC), 2015, (The Woodlands, Texas)
8. JPL Postdoc Research Day 2014, (Pasadena, CA)
9. Rocky Mountain Conference on Analytical Chemistry (RMC), 2013 (Denver, Colorado)
10. European Conference on Silicon Carbide and Related Materials (ECSCRM), 2012 (St. Petersburg, Russia)
11. Rocky Mountain Conference on Analytical Chemistry (RMC), 2012 (Copper Mountain, Colorado)
12. Workshop on Dielectrics in Microelectronics (WoDiM), 2012 (Dresden, Germany)
13. Physics and Chemistry of Semiconductor Interfaces (PCSI) 2012, (Santa Fe, New Mexico)
14. Rocky Mountain Conference on Analytical Chemistry (RMC), 2011 (Snowmass, Colorado)
15. Rocky Mountain Conference on Analytical Chemistry (RMC), 2010 (Snowmass, Colorado)
16. Rocky Mountain Conference on Analytical Chemistry (RMC), 2009 (Snowmass, Colorado)
17. European Conference on Silicon Carbide and Related Materials (ECSCRM), 2008 (Barcelona, Spain)
18. Nano and Giga Challenges Conference (NGC), 2007 (Tempe, Arizona)
19. International Conference on Silicon Carbide and Related Materials (ICSCRM), 2007 (Otsu, Japan)
20. Rocky Mountain Conference on Analytical Chemistry (RMC), 2006 (Breckenridge, Colorado)